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METROPOLIS WATER SUPPLY.

ON THE

SUPPLY OF WATER

TO

LONDON.

ROYAL COLL... ENGLAND
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METROPOLIS WATER SUPPLY.

About forty years ago, the great community living within the somewhat indefinite area known as the metropolis, were probably as well cared for as most cities of the old world in matters of sanitary regulation and convenience, according to the limited knowledge and experience which then obtained. Since that time, an important system of Main Drainage has been carried out, and the slimy shores of the Thames have been hidden by the costly Embankments which have been erected.

More recently, efforts have been made to improve the paving of the roads and streets by adopting asphalte and wood, while not very successful attempts have been made to copy the systems of granite paving long introduced into northern provincial cities and towns.

In the hands of private companies and vestries, the gas lighting of the public streets is still unsatisfactory, while the mechanical contrivances and the system of distributing water throughout the great metropolis are notable for the absence of all the improvements which, for a generation, have marked the advance in this essential to public health in other places in Great Britain as well as abroad.

The idea seems to be prevalent, in some official minds, that things in London are not capable of improvement, and the fact of any new system or contrivance, however successful elsewhere, if it has not been adopted in the metropolis, is taken, without enquiry or consideration, to be proof positive that the thing is not a success.

As regards the gas lighting, it may be said that the companies have, in self-preservation, adopted all the improvements which from time to time have been discovered in relation to its manufacture and distribution, and the public lighting remains as it is, probably, because the vestries or other local authorities do not consider any improvement possible or requisite.

In a measure the same remarks may be applied to the water supply. As regards the source of supply the companies have, more or less, fulfilled the obligations imposed upon them by Parliament. Since 1852, in consequence of the Legislative enactments of that year, the intake works of the Thames Companies have been removed from within the tideway to above the lock at Teddington, beyond which the tide does not flow. The water is filtered according to the same antiquated system of 40 years ago, and the supply is generally distributed "intermittently" to the inhabitants for 20 minutes of each day. In case of fire, the old system of the wooden plugs is still generally prevalent, and the pressure in the mains is rarely sufficient for the extinction of fires without the use of engines.

The improved supplies of water to most provincial cities and towns during the last thirty years by the provision of *pure* water, its distribution under the " constant supply " system and at high pressure, rendering the use of engines in the case of fire not always essential, have from time to time induced sanitarians to desire that London, the metropolis of the wealthiest nation in the world, should not be behind in regard to the supply of that which is alike the necessity and the comfort of life and good health, an abundant supply of pure water.

From the year 1850, when the question was taken up by the General Board of Health, to the year 1865, many proposals for this object were made, but all were allowed to die or were consigned to the waste paper basket.

In November of the latter year (1865), however, Mr. Bateman, the Engineer of the Manchester and Glasgow Waterworks, published a pamphlet with the following title :—" On the Supply of Water to London from the Sources of the River Severn."

In this publication, as the title sets forth, he proposed a scheme for bringing in an entirely new supply of water by gravitation from the upper sources of the Severn, in Mid-Wales.

The works proposed were laid out to supply 220 million gallons a day for a total estimated outlay of £10,850,009—a supply of 130 million gallon per day, at an estimated cost of £8,600,000, being introduced as a first instalment.

Mr. Bateman's scheme contemplated, as a matter of course, the absorption of the Water Companies, and the abandonment of the existing sources of supply from the Thames and from the River Lee, as being objectionable sources for a domestic supply to the metropolis ; and he recommended that the whole metropolis should be formed into one district for the purposes of water supply, under the charge or control of a Water Commission or Corporation, to be invested with powers—(as in Manchester, Glasgow, Liverpool, and other provincial towns)—to levy compulsory rates for providing annual compensation to the Water Companies, the interest on the outlay for new works, and the necessary working expenses.

The publication of Mr. Bateman's pamphlet attracted other engineers to the subject, and different schemes, having generally the same object in view, were projected during the ensuing year.

The public mind being thus directed to this important subject, the then Government issued a Commission, which has since been known as "The Royal Commission on Water Supply," consisting of the Duke of Richmond, the late Sir John Thwaites, the late Colonel Harness, Sir B. S. Phillips, Mr. T. E. Harrison, C.E., and Mr. Joseph Prestwich, F.R.S.

This Commission was appointed on the 24th December, 1866, and their Report (with the Minutes of Evidence which was given before them, and plans and other documents), was issued on the 9th of June, 1869.

The summary of conclusions and recommendations of this Commission, so far as relates to the water supply of the metropolis, is set forth in paragraphs 257 to 263 inclusive of their Report, and they may shortly be stated to be an expression of opinion—

1st.—That Mr. Bateman's scheme to bring in water from Wales was feasible and practicable, and that by it a large supply of water might be obtained for the metropolis.

2nd.—That the existing sources of supply available from the Thames Basin, were ample for all the wants of any possible increase of the metropolitan population.

3rd.—That there was no evidence to lead the Commission to believe that the quality of the water then supplied was not generally good and wholesome, and that, when efficient measures were adopted for excluding sewage and other pollutions from the Thames and the Lea and their tributaries, and for ensuring perfect filtration, water taken from the present sources will be perfectly wholesome and of suitable quality for the supply of the metropolis.

4th.—That a probable increase of population to 4,500,000 or 5,000,000 may at some very remote period have to be provided for, and that 200 million gallons per day is the "highest demand" that need be reasonably looked forward to for the metropolitan supply.

5th.—That a constant supply of water ought to be promptly introduced, but that this system cannot be effectually carried out in the hands of private companies; and

6th.—That the general control of the water supply should be entrusted to a responsible public body with powers conferred on them for the purchase and extension of existing works, and with powers for levying the necessary rates.

Since the issuing of this Report the question has been fitfully taken up, and as fitfully discarded again, without any practical result. In the year 1877, however, the Metropolitan Board attempted to deal with the matter, and introduced two bills to Parliament during the Session of 1878. The object of one Bill was to obtain powers to acquire the works and properties of the companies. The object of the second Bill was to obtain powers to sink wells in the chalk at various points in the neighbourhood of London, with a view of obtaining a supply of pure water from that source. The supply thus to be obtained was estimated at 16 million gallons a day, and was to be distributed throughout the metropolis by a separate system of piping for the use of the inhabitants for drinking and dietetic purposes, and, being delivered at high pressure, it would be available for the extinction of fires. The Engineer's estimate of the cost of the works was £5,440,000, exclusive of the subsequent annual cost of pumping and maintenance.

The action of the Metropolitan Board of Works in the matter failed to command the support of the Government, and roused the opposition not only of the Water Companies (which was naturally to be expected), but also that of many of the Vestries, and both Bills were withdrawn.

The remarkable increase in the population supplied by the eight Metropolitan Water Companies, and in the quantity of water consumed during the ten years which have elapsed since the Report of the Royal Commission on Water Supply, and the frequent complaints of the quality of the water and insufficiency both of quantity and pressure for the extinction of fires, have again brought this question prominently before the Houses of Parliament. It may be that the examples which have been set by provincial cities like Manchester, Glasgow and Liverpool, in providing ample supplies of pure water, *constantly* laid on at high pressure, are at length beginning to tell upon those who generally guide the inert mass forming the population of this great metropolis.

By a singular coincidence, on the very evening that Lord Granville recently called the attention of the House of Lords to the deficiency of the water supply of the metropolis in cases of fire, the Royal Assent was given to the Bill of the Manchester Corporation for obtaining a further supply of water for that city and its district, which is to be brought from a Cumberland lake, at a distance over 100 miles from the centre to be supplied.

Thirty-four years previously, Manchester, in the van of all towns for its municipal and public improvements, obtained powers to construct waterworks which would afford a supply of about 25 million gallons of water a day, The population of the Borough of Manchester at that time amounted to about 300,000 persons. In the period which has since elapsed, Manchester has not only had to supply the population within its own municipal boundary, but Salford, and no less than 36 adjoining townships, besides a partial supply to Stockport. Many of these townships are places which have been created within this time; and the population now dependent for a supply of water from the works of the Manchester Corporation is about 800,000 persons, the population increasing, and the supply required for such increase being at such a rate that the present sources will be exhausted by the time the new supply from Lake Thirlmere can be introduced.

In acquiring the Old Waterworks Company, and in executing the works for a new water supply from the Longdendale valley, the Corporation have up to the present time expended upwards of £2,500,000, and they are bold enough to go one hundred miles from Manchester, and to contemplate a further expenditure of £3,425,000, to bring in an additional supply of 50 million gallons a day.

The water supplied to Manchester now, and that which is to be obtained from Lake Thirlmere, is of the purest character, derived from wild and uncultivated mountain and moor land, and of only one to two degrees of hardness.

Such a supply of water Mr. Bateman proposed to give to the inhabitants of the metropolis by the scheme which he propounded in 1865, for introducing an entirely new supply from the upper sources of the Severn; and the districts selected by Mr. Bateman there, and other contiguous districts, are still open and available for the supply of pure soft water to this great metropolis.

In 1864 the nett earnings of the eight London Water Companies were, as far as could be ascertained from the imperfect accounts then published, in round numbers £450,000 per annum, and it was then proposed that this amount should be secured to the shareholders of the Companies as a first charge upon the rates of the whole metropolis.

Assuming the value of money at 25 years' purchase, this annual rent charge of £450,000 would represent £11,250,000 of capital. The actual capital then spent by the Companies was only £8,641,212.

In 1877, being the period up to which the last returns of the Water Companies ordered by Parliament are published, the amount actually paid in dividends and interest on borrowed money was £760,364. If, as was proposed in 1865, this amount were secured to the Water Companies as a first charge on the rates of the metropolis, it would represent a capital of £19,000,000 in round numbers, showing an increase in the value of the vested interests of the Water Companies in this period, of £7,750,000, whereas the actual expenditure on capital account by the eight Water Companies during this time has only been £3,184,369.

These figures show how important it is that no further time should be lost in carrying into effect the valuable opinion and recommendation of the Royal Commission on water supply, namely:— " That the future control thereof should be entrusted to a responsible public body, with powers conferred upon them for the purchase of the works . . ."

It may not be inopportune here to observe that, had the proposals made by Mr. Bateman in 1865 been acted upon then, the interest of the Water Companies could have been acquired at a cost equivalent to a capital of £11,250,000, and a new supply of 130,000,000 gallons per day of pure, wholesome, soft, water could have been introduced into the metropolis at an estimated cost of £8,600,000, together £19,850,000, or only £850,000 more than the amount which will *now* have to be paid to the Water Companies for their vested interests for a water supply which is generally admitted to be inferior in quality, insufficient in quantity and pressure when most required in times of fire, and delivered as now, on that most objectionable system of intermittent supply.

In 1868, in giving evidence before the Royal Commission on Water Supply, Mr. Bateman ventured to estimate (the then consumption of water being about 95 million gallons per day) that by about 1875-1876, the supply would be about 130 million gallons per day. In July and August of the year 1876, the average daily supply exceeded 135 million gallons. Taking the average of the year 1878, the daily supply was nearly 130 million gallons, the exact figures being 129,666,191; but the supply during the months of July and August averaged upwards of 146,500,000 gallons per day.

It is important to bear in mind that the time of maximum demand by the inhabitants is the time also when the companies, deriving their supplies from the River Thames, are taking it from that river in its *lowest* state, when the relative proportions of town sewage and land drainage brought into the river above the point of the Water Companies' intakes is greatest with reference to the water in the river with which the sewage and land drainage mix. A heavy shower or thunder-storm at such seasons washes out the foul accumulations in the sewers and land drains into the river, and the water is then highly charged with organic matter.

At the present rate of increase in the population supplied by the Water Companies, the period of maximum population is by no means so remote as the Royal Commissioners contemplated in 1869. So with reference to the consumption of water, the period of the "highest demand," which the Royal Commission estimated at 200 million gallons per day, cannot be very distant, for the supply has increased from 95 million gallons in 1869 to 130 million gallons on the average of the year 1878, and to 146½ million gallons, taking the average of the two summer months of July and August, 1878.

As Mr. Bateman's scheme would have possibly been considered an impracticable one if no financial benefits were to result to the ratepayers, it may be useful to consider how far what he then thought might be probable, has been actually realized in the years which have elapsed.

The rateable value of the metropolis in 1865 was £14,524,797, and Mr. Bateman estimated that in seven years thereafter (by which time the works for bringing a new supply from Wales could be completed) the assessable value might have increased to £18,000,000. In the year 1878, the rateable value of property within the area of the Metropolitan Board of Works was £23,960,109, and the population within that area was estimated at 3,577,304 persons. The number of persons, however, actually supplied with water by the eight companies in January of this year, was 3,982,383, the excess, 405,079 (being the population outside the metropolitan area), representing, in all probability, an assessable value of property of not less than £2,000,000 more, so that the rateable property supplied with water by the eight Water Companies, amounts to about £26,000,000.

Had Mr. Bateman's scheme of 1865, been carried out in its entirety at that time, the annual rent charge to the Water Companies, and the annual interest and working expenses for introducing a new supply of pure water from Wales, to the full extent of 220 million gallons, could have been met at the present day by a public rate of 3d. in the pound, and a domestic rate of about 7d. in the pound on the assessable value of the properties.

The present charges of the Water Companies are generally equal to 1s. in the pound on the actual *rental* of the property, which is one-fifth more than the *assessable value*, and in many cases the charges are higher; so that the inhabitants of the metropolis now pay on the average what is equal to at least 14d. in the pound on the assessable value, whereas they might be receiving now an unstinted supply of pure water, delivered at high pressure, for not more than 10d. in the pound on the assessable value.

It is scarcely necessary to criticise the abortive scheme of the Metropolitan Board for introducing a supply of water from the chalk for purely drinking and dietetic purposes. To expend 5½ millions of money as was proposed, in furnishing a supply of only 16 million gallons of water per day, involving the duplicating of the water-pipes in every house and in every street of the metropolis, the latter having an aggregate length of over 1,500 miles, would be the height of absurdity, when for only *twice* that amount, more than *fourteen* times the quantity of equally pure and *soft* water could be brought in from Wales, and the supply for *all* purposes to the metropolis could be furnished by utilizing all the existing mains and pipes.

The advantages of a supply of pure soft water, such as is enjoyed by Manchester, Glasgow, Bradford, Halifax, Bolton, Oldham, and indeed most of the important centres of population in the north of England and Scotland, are so well known and appreciated, that one would think it scarcely necessary to compare soft water with the hard water supplies obtained from the River Thames, and the River Lea, and from the chalk.

Mr. Bateman gave the following evidence before the Royal Commission, on Water Supply, on the benefits and economies resulting from the use of soft water. Being asked if he was of opinion that there was great advantage and economy in using soft water? he answered:—

> "Yes. Because it produces lather with a less amount of soap; you use less tea for making tea, and you use less coffee for making coffee. A great amount of evidence has been given upon that subject to the Board of Health, and I believe that it is reliable evidence. I can give you the actual result in Glasgow from the introduction of the Loch Katrine water. According to Dr. Clark's test, the water is about from one to two degrees of hardness, and this is not in flood, when it is softer, and from which the great body of water would be obtained and stored, but these are the streams in dry weather, when the water is always harder."

(He read the following table):—

TABLE of the ANALYSIS of WATERS collected from the Streams which are proposed to be abstracted for the Supply of the Metropolis from North Wales, by the late Dr. ROBERT DUNDAS THOMSON, F.R.S.

	Total Impurity.	Organic Impurity.	Total Hardness.
	Grains per Gallon.	Grains per Gallon.	Degrees.
River Vyrnwy, at Pont Hagel ...	2·60	·72	1·8
River Banw, at one mile below Can Office	2·84	1·16	1·8
River Clywedog, at Llanidloes Bridge	6·80	1·40	1·1
River Severn, and Afon Dulas, at Llanidloes Bridge*	9·92	1·96	1·4
River Severn, at Caer Sws	7·24	1·44	2·2
COMPARATIVE ANALYSIS OF OTHER WATERS:			
Loch Katrine Water Supply to Glasgow	2·35	·605	·8 in the Loch.
Manchester Water Supply	3·33	·680	1·5 as supplied in the City.
Bala Lake	2·08	1·28	·8 in the Lake.

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* In this sample was included water from the Hafron Brook, or River Severn proper, which stream is excluded from the scheme in consequence of mineral workings at the head of the valley.

" In the Bala Lake, where the water is received from precisely the same geological district, but is impounded flood water to a great extent, the water is only 8/10ths of a degree of hardness, and that will probably be the quality of the water when impounded in reservoirs. The Loch Katrine water is ·8 in the loch itself, which is precisely the same as the Bala Lake water, and which may be expected to be the same as the water collected in reservoirs if impounded is this district. The Manchester Water Supply varies from 6/10ths of a degree to about 2 degrees in the stream itself, and as delivered in the city it is of about 1½ degrees of hardness. I believe that there is no better supply of water in the world than at Manchester. The water of the Clyde, from which Glasgow was formerly supplied, varies according to weather between 7 and 9 degrees of hardness, and the water which supplies this city varies between 13 and 15 degrees of hardness. In the primitive formation, in the millstone grit formation, and in some sands, the water is soft. From chalk, from oolite, from lias, and from the new and the old red sandstones it is always hard, taking the hardness to begin at 5 degrees. I believe it is all hard above that point. Therefore, it is of importance in selecting water for a great district that you should go to a soft supply. The saving of soap in Glasgow, after the introduction of the Loch Katrine water, which was introduced on one day and never taken from the city again, was as follows :—The manufacturers who used large quantities of soap, and who knew what their consumption was, found that they did the same work better with three boxes of soap than they had done previously with eight boxes of soap, so that they saved 5/8ths of the soap previously used. I personally inquired amongst some of the large printers and those who used water in Glasgow, and the saving varied from fully half to 5/8ths, but the most general computation was that the saving was one-half and I know that the result was better bleaching and purer colours. Then, from calculations made by very careful housekeepers, they calculated that the saving in soap by the use of the Loch Katrine Water, to say nothing of the wear and tear of clothes in washing, was quite equal to the rate which they paid for water, and upon the north of the river it was then £36,000 a year, so that the saving to the City of Glasgow upon a population of 360,000 or 370,000 persons, being the population upon the north of the Clyde, amounted to £36,000 a year, or 2s. per head per annum. The reports to the Board of Health particularly dwelt upon that point; they obtained a great deal of information, and amongst the rest, information from Dr. Clark, who invented the particular test which goes by his name as Dr. Clark's soap test. The quantity of soap taken to produce a lather in a given quantity of London water of 15 degrees of hardness was 30¼ oz., and the quantity required to produce the same amount of lather with water of 4 degrees of hardness was 9½ oz., which was less than one-third of the soap, the difference of hardness being 11 degrees. Amongst other enquiries, they made many enquiries with respect to cooking by M. Soyer, and he went very largely into the effect upon vegetables, and found that there was an economy altogether in cooking. The result was that two-thirds of the quantity of anything which had been previously used produced as good a result as the three-thirds with hard water.

" Taking cabbage for instance, I mean that you get a better dish of cabbage, of a better colour and flavour, and more nutritious, boiled with soft water than boiled with hard water ; and that if you make tea you get an equally good cup of tea with two thirds of the tea, as with three thirds. Then Mr. William Hawes, who also gave evidence to the Board of Health, he being a large maker of soap, estimated the consumption of soap in London, in 1844, at 15 lbs per head per annum for the wealthy classes, 10 lbs for the shop keepers and tradesmen, and 4 lbs for the labourers, bringing out a result of 200 tons per week. That makes the total quantity of soap used in the year, 10,400 tons, which he put at £45 a ton, (which I suppose is the wholesale price), making the value of the soap consumed in London at that time, £468,000. Dr. Clark in the year 1850, six years later than that, estimated the consumption of soap used in London at 12,000 tons, being 1,600 tons more than Mr. Hawes estimated it at in 1844, so that the calculations may be said to be both the same. Dr. Clark estimated the price at £50 a ton for 250 tons per week, and he calculates the soda at £10 a ton ; that makes for the soap £600,000 a year. Since that time nearly 20 years have elapsed, the population having increased in that period 50 per cent., and soap may be supposed to have increased also, which would make as nearly as possible £1,000,000 a year as the actual value of the quantity of soap used in London by the inhabitants. Now, if with soft water, half the soap will do what is requisite with hard water, there is an annual saving in soap alone of half a million of money. I merely throw that out as the result of actual observation and consideration. I may mention that in my own house in the country, I introduced about three years ago, very soft water, equal to Loch Katrine water, in place of hard water which I had before, and the saving amounts to about 4s. or 5s. per head upon the household soap used in my establishment for house purposes and for washing. It amounts, I think, to from £3. 10s. to £5 a year, and for six months in the year my establishment consists of about 25 persons, and the washing goes on all the year round—that is in soap alone. Those who know the delight of washing in Manchester or in Glasgow in the water there supplied, as compared with the London water, will understand the difference. The Londoners and those unaccustomed to the use of soft water can hardly get rid of the soap, for all that you have to do with this water is to touch the soap and you have soap enough to wash yourself perfectly. In many other ways, in the health of the people, and in the wear and tear of clothes there are savings. It is difficult to put the matter in figures, but if they save in Glasgow some £40,000 a year upon a population of 400,000 they would save in a population of 3,000,000, £300,000 a year, supposing the difference in the hardness of the water to be the same. In Glasgow the change is from water of about 8 degrees to water of about 1½ degree, and this would be a change in London from water of about 15 degrees to water of 2 degrees, and the saving would be proportionately greater here. I could go very much more largely into this point, but I think that that is sufficient. In the same report of the Board of Health, there is the evidence of Mr. Temple, a barrister, who speaks as to the effect of the Paisley water, where hard water was done away with and soft water substituted, and he says that there were various complaints diminished by the use of soft water. The Waterworks manager in the same town gives evidence upon the same point, and he says that from experiment London water requires twice as much soap as Paisley water; and he also confirms the evidence as to the diminution of dangerous diseases.

"In Glasgow the new outlay for water was about £1,000,000, besides the purchase of the old companies, which made the whole cost about £1,600,000. The inhabitants get their water at the same rate as they had previously paid the Water Company, and therefore they paid no more for their water, although they laid out £1,000,000. The saving in pumping, and the increase in the population, and the demand for water were such that after the first two or three years, during which they did pay a little heavier rate, the rate fell to the same price as it had been before the introduction of the new water, and from this time it will be lower. If, by the use of that water they saved a sum equal to their whole rate, they saved about

£40,000, which at four per cent. were equal to £1,000,000, which they put into their pockets."

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Near the conclusion of the enquiry Mr. Bateman gave further evidence on the same subject before the Royal Commission, and stated as follows:—

> "You have had before you nearly 50 witnesses; of those 16 had not any occasion to express an opinion upon the quality of the water, and they did not express an opinion, it did not fall within the scope of their evidence. *You have had 27 who have all expressed an opinion in favour of soft water, some of them very strongly in favour indeed. You have one single gentleman who has expressed a decided opinion in favour of hard water, and you have had one gentleman who has expressed a qualified opinion in favour of hard water.* Amongst those who have expressed a very strong opinion in favour of soft water are Mr. Rawlinson, Professor Way, Professor Ramsay, Mr. Duncan, Dr. Lyon Playfair—to whose evidence I must specially draw your attention—Mr. Simons, Dr. Farr, who also very specially referred to it, Dr. Parkes, and Dr. Frankland, and with him Dr. Odling. I would refer upon that point to the evidence which I gave on the first occasion on which I had the honour of being examined before you. I read that evidence over this morning, and I do not think I can add much to the facts which I then stated nor put them in a better form. I mentioned that in my own house I saved half the quantity of soap which I formerly used by the introduction of soft water at my house in the country, and that I saved from 4s. to 5s. a head in a year. I find that the soap, which I buy for my household in large quantities, cost me, before the introduction of soft water, between £10 and £11 for about fifteen months' consumption; that since the introduction of soft water, which I introduced in the autumn of 1864, the soap which I previously used in fifteen months now lasts me more than two years, my household consisting almost exactly, as nearly as a household can do, of the same number of inhabitants and under the same conditions, in fact, if anything, there is a larger consumption of soap now going on, or rather the operations which require soap are now of a more extended character than they were previously to the introduction of soft water. I save £5 a-year, and if I measure that by my population by from 20 to 25, I save from 4s. 6d. to 5s. per head per annum in the use of household soap alone. This does not

include the soap which is used in the family bed-rooms, nor toilet soap, but merely the household soap and the soap used by the servants. I simply add that to the evidence which I have already given."

"The water of the Welsh District is generally very soft water. I may observe that if the saving were only 2s. a head a year upon the population of 3,000,000 in London, that would be £300,000 a year in the saving of soap alone, to say nothing of the wear and tear of clothes and all other things which might enter into the consideration; but the saving in soap alone would pay the interest of the whole outlay which is supposed to be necessary."

The Royal Commission omit to refer to this evidence in that portion of their report which deals with this subject, and their conclusion is that soft water is not much more advantageous than hard water, because *after boiling* the hardness is reduced to a point when it may be considered soft. "After boiling!" How long? London water will have to be boiled for sixty minutes before it is reduced to 2·4 degrees, the soft water from Wales when cold being only 1 or 2 degrees.

One strong objection urged to the water from Wales was on account of its colour, it being alleged that it would be "commonly coloured" from peat. Similar objections were taken thirty-four years ago to the then proposed supply of water to Manchester from Longdendale, and samples of water were gravely produced, in colour as brown as coffee, as the kind of water which would be supplied from the new works. It is true that at certain seasons of the year, some of the streams which feed the reservoirs of the Manchester Corporation Water Works are, for a time, deeply stained by peat, but the effect of exposure in the large reservoirs is to remove almost entirely all colour, and the water as delivered in Manchester and as seen in a tumbler on a dining table, is certainly as white and bright as the supplies afforded to the inhabitants of London from the present polluted sources.

Were no Loch Katrine in existence, and a reservoir had to be made for impounding the waters of the streams which now descend the hills forming the basin of the Loch, the same strong objections to a supply of water from that district on account of peat stains would obtain, for in rainy weather, which is the time when gravitation waterworks receive their supplies of water, the two principal streams feeding Loch Katrine flow into it as brown as porter, but the effect of exposure in the large surface of the lake ærates the water, and is such that where it is taken from the lake for the supply to Glasgow, a piece of white porcelain, seen at a depth of five feet, is only changed to a very pale straw colour. In cold weather and in the depth of winter the water may be said to be absolutely colourless.

The same objection as to colour might be urged against almost every supply of water which is obtained by gravitation in mountainous districts; but the experience of the past thirty years, since the construction of the reservoirs of the Manchester Water Works, has proved conclusively that all objectionable, and indeed *visible* peat stain in water is removed by exposure in open reservoirs or lakes. What has resulted in the Longdendale works of the Manchester Corporation may reasonably be expected to result in the large reservoirs and lakes which Mr. Bateman proposes to construct in Wales for the storage of water for the supply of the metropolis, and the objection raised on account of colour is "straining at a gnat," as regards a pure supply of water from Wales, and "swallowing a camel," in continuing to drink and use a supply of water from the Thames and the Lea, which are polluted by the sewage and fouled waters from upwards of a million of persons living above the points of intake, as well as by the washings of some of the most highly cultivated and manured lands in Great Britain.

The opposition of the Water Companies to the introduction of a system of constant supply, and the extravagant and foolish estimates adduced in their behalf to show the enormous outlay which would have to be incurred by the inhabitants of the metropolis, have been successful is misleading Parliament on this question, and it has resulted that all the enactments requiring constant supply are practically inoperative. Conditions and restrictions are imposed upon the consumers which are not only unnecessary, but in some cases mischievous, and they are such as are never required in any place where the system of constant supply is in operation. Professional witnesses have been ready to give evidence that the average cost of introducing the constant supply in the metropolis would be any sum between £5 and £10 per house, or say on the 500,000 houses supplied with water in the metropolita district, from £2,500,000 to £5,000,000.

More wild and absurd estimates still have been made of the cost of fixing fire hydrants in the metropolis. One high professional official, who cannot conceive of any good thing being adopted outside of London, considers that each hydrant should cost "about £20 a piece one with another," whereas the cost of the hydrant and fixing in Manchester, Glasgow, and other provincial cities and towns, does not exceed £2 or £3 per hydrant.

Much evidence was given with reference to the introduction of a system of constant supply, and also as to the cost of altering the house fittings and the fixing of hydrants for the extinction of fires. The evidence of Mr. Bateman, which is given below, is perhaps the most important because he gives his experience not only as an engineer, but as a director for many years of Water Companies.

> Sir J. Thwaites asks: "Under the present system of supply in London, is it not the case that the companies shut off a certain area of distribution of water during certain hours in the day, and in case of a fire, unless the water is turned on to that district, there is no means of suppressing a fire in the metropolis? Mr. Bateman answers: That is so.
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> "But with the principle of the constant supply, you would have water in every district, and although you may not be able to use it from a hydrant, still you would constantly have water which could

be pumped upon a fire which might occur in this district? Yes, the advantages of a constant supply in case of fire is very great indeed; it can hardly be over-estimated, and I have the means of showing the Commission the result of an abundant supply of water under high pressure in Manchester, from a report as late as the 8th of January, 1868."

"What height can you throw water from your mains by means of hose? When I laid out the supply of water in Manchester (it was the first city which obtained the power of levying compulsory rates upon all property and upon all houses), and I thought it was only right, that warehouse property for instance, and other valuable property which did not take water for domestic purposes, should have the best possible protection and the greatest advantage that could be conferred upon them for their public rate, and I therefore laid out the pipes in the centre of Manchester, where the property was the most valuable, specially with a view to the extinction of fire and the protection of property; and there is no large block of buildings in Manchester which is not commanded within 100 yards by at least 20 fire-cocks. Fire-engines have been discontinued except as omnibuses to carry men and utensils. The pressure is such as will throw the water from the street over the highest building. The pipes are interlaced in such a way that the fire-cocks are not dependent for their supply upon one particular main, but the various mains are so interlaced that if one should be out of order, or should be overdrawn, other pipes would be able to deliver water. The result of that state of things is pretty much this:—I have here before me a return of the amount of property destroyed, and property saved on occasions when fires have occurred, from 1844 to 1867. The water was introduced into Manchester about 1851, but it hardly got into full use till about 1853. We had to change from the old intermittent system—as bad as anything could be—to the constant system, and we were very careful in taking it by districts, so that every district should be brought under the surveillance of proper officers, district by district, before we admitted it to the advantages of a constant supply, and in that way it was that we reduced the consumption so much. The percentage of property destroyed from 1846 to 1850 before the introduction of the water was 21·3 per cent. of the value of property attacked by fire. The amount saved out of such property was 78·6 per cent. From 1851 to 1855, Manchester, for half the time at least, not having advantage of high pressure, and for the latter two years of the time having it, and therefore it would be partly under the old system and partly under the new, the percentage of property destroyed was 12·9 per cent., and of that saved 87 per cent. Then came the advantage of the constant supply and high pressure, with a full water supply ; and from 1856 to 1860, the percentage destroyed was only 7·7 per cent., being only one-third the amount which was destroyed before the introduction of the fresh water supply, and the amount of property saved was 92·2 per cent. From 1861 to 1865, the amount of property destroyed was 6·7 per cent., and the amount saved was 93·2 per cent. I do not think it is possible to have a stronger elucidation of the great advantage which arises in case of fire from a full water supply."

"*Then you have reduced the loss from* 21 *per cent. to* 6·7 *per cent.? Yes; taking the two lowest, it is from* 21 *to* 7, *and the increase in the amount of property saved is from* 78·6 *to* 93·2."

"With regard to the condition of the mechanical arrangements for the supply of water in the metropolis, what, in your judgment, would be the cost per house of putting them into such a state as to resist the pressure and adapt them to the constant supply? If the fittings are now, with the exception of the tap, such as are ordinarily put in, they would now be quite sufficient. I have changed the supply from intermittent to constant supply in a great number of towns, and I never heard anything like a complaint of the bursting of pipes by introducing the new system ; in London, plumbers are allowed to do whatever they choose, and not one of the Companies exercises the slightest supervision over them ; the probability is that they put in perhaps rather too strong than too weak fittings ; but in all works with which I am connected I arrange the strength of the pipes according to the size, and according to the pressure, and the kind of tap to be used, and we require the plumbers to put them in. In very many cases, Corporations cannot do that, from the public outcry that is made ; but in all private Companies of which I can get the control, the Companies do all their plumbing work themselves at a fair price, so as not to injure the plumber, and they make a considerable profit, and put in nothing but the best fittings."

"Do they use leaden pipes? Yes, they use leaden pipes ; wrought iron pipes will not do ; they corrode and burst. I tried them in my own house, and that was the result ; but with leaden pipes and the best taps which can be employed, the whole cost of introducing water into a cottage house, for instance, is about 12s. to 15s.

" Is that the whole cost to make it fit for the constant supply ?—Yes, that is the whole cost if you have to do it *de novo*, and surely it will not cost more to fit it for the constant supply than to do the whole thing afresh. Supposing there is any doubt about it, if you strip it all away, and put in a fresh thing, it will only cost 12s to 15s. in a cottage house.

" Then are we to understand that the infirmity of the old system is rather due to the condition of the taps than to the pipes? I believe that is the case everywhere. It may be that, having been put in without supervision, some of the pipes are too weak and will burst, but they will find themselves out very shortly; they may occasion a little annoyance in the first instance, but in the course of a week a weak pipe will tell for itself and will burst, and you will have to put a stronger one in. Take any house in this neighbourhood, my own house in Great George Street, for instance, where the water is introduced into cisterns, I should make no alteration, I should use the pipes as they are. I would not incur the expense of £8, as has been mentioned, but I should have a plumber to see to the pipe which conveyed the water from the street, and if it was at a higher pressure (and by the arrangements which I now propose it would not be at a higher pressure) I might change the ascending pipe from the street to the cistern, nothing more, and put a stop tap upon it; and then, if I had any tap likely to run the water to waste, I should change the tap and put a better one. That is all I should do, and that is all anyone would do with an old house, but if you were coming to a new house in a great number of cases you would do without a cistern, because, under the constant supply system, a cistern is not necessary. Of course, if the water should be shut off for a few hours in order to attach any of the services, it is convenient to have a cistern, but it is not necessary, and the idea of spending £8 or £10 upon a house in altering the fittings upon a house is preposterous. I am not speaking now as an engineer only, but I am speaking as a director of water companies, and I have had to do the whole thing and know all about it. In answer to a question which has been put to me, with regard to how much the waste of water could be reduced, I may state a fact which occurred at Stockport. I happen to be the Chairman of the Stockport Waterworks Company. There were some cottages which were supplied with water-closets and without any meters. A meter was put down by the gentleman who owned the property, and he paid by meter, and it

> was found that they took 80 gallons per head per diem. He was so astonished and so annoyed at having to pay such an amount for the water used that he did away with the water-closets, and he was supplied by meter for six months without water-closets, and the consumption for other purposes than water-closets was found to be 12 gallons per head per diem, so that water-closets are the great consumers of water unless they are of the best possible construction. Those were common syphon closets."

Every year which is allowed to elapse before the great question of Metropolitan Water Supply is dealt with, as it ought to be, by the Government, the value of the vested interests of the Water Companies increases, as also the cost of assimilating a new supply to the present means of distribution.

As has been already stated, the companies, since 1865, have expended on new works, or extensions of their existing works, £3,184,369, whereas the increase in the market value of their undertakings is probably £7,750,000, so that as time elapses, for every 20s. invested by the Water Companies, the ratepayers of London in some shape or other, have to pay them 48s.

Fortunately, the increase in the value of the property in the metropolis, and in the surrounding districts which are naturally dependent upon the metropolis for a supply of water, has been so great that if Mr. Bateman's proposal of 1865 were even now adopted, the direct financial advantages which he anticipated to the community at large, would be realized. The rates to be levied would not exceed 3d. in the pound on all property as a public rate, and 9d. in the pound on dwellings for a domestic rate. Even these two rates equal together to 1s. in the pound would favourably compare with the present charges of the companies of 14d. in the pound for the present unsatisfactory supply.

For the year ending December 31st, 1877, the water rents receivable by the Water Companies, amounted to no less a sum than £1,318,603.

Assuming Mr. Bateman's recommendations to be carried out, the annual rent-charge to the Water Companies of £750,000, interest on £10,500,000 at 3½ per cent, for bringing in 170,000,000 gallons a day from Wales, £367,500, management, rates and taxes, and maintenance of works £200,000, amount together to a total charge of £1,317,500, almost exactly the amount received by the Water Companies in 1877. It is apparent, therefore, that at the end of seven years, when the new supply from Wales might be introduced, the amount to be levied from the ratepayers of the metropolis and adjacent districts, need not exceed that which was received in the aggregate by the Water Companies in the year 1877, although, by that time (*i.e.* seven years hence), the assessable value of the property upon which the rates would be levied will have increased by between one-sixth and one-seventh, thus the rate payable by each house-owner would be reduced correspondingly, or say from 14d. in the pound, as now charged by the Water Companies, to 1s in the pound, as estimated above.

In Glasgow, the public and domestic water rates together are now only 9d. in the £. within the municipality, and 11d. in the £. outside the municipality. The revenue thus obtained, and from the sale of water for trading purposes and to other local authorities, is sufficient to pay the interest on over £2,000,000 sterling and the annual working expenses, and to provide nearly £20,000 per annum for a sinking fund. There, the Corporation purchased the works of the Water Companies, and spent over £1,000,000 for a new supply of water from Loch Katrine, and in eight years the rates were reduced within the municipality from 17d. in the £. to 9d. in the £.